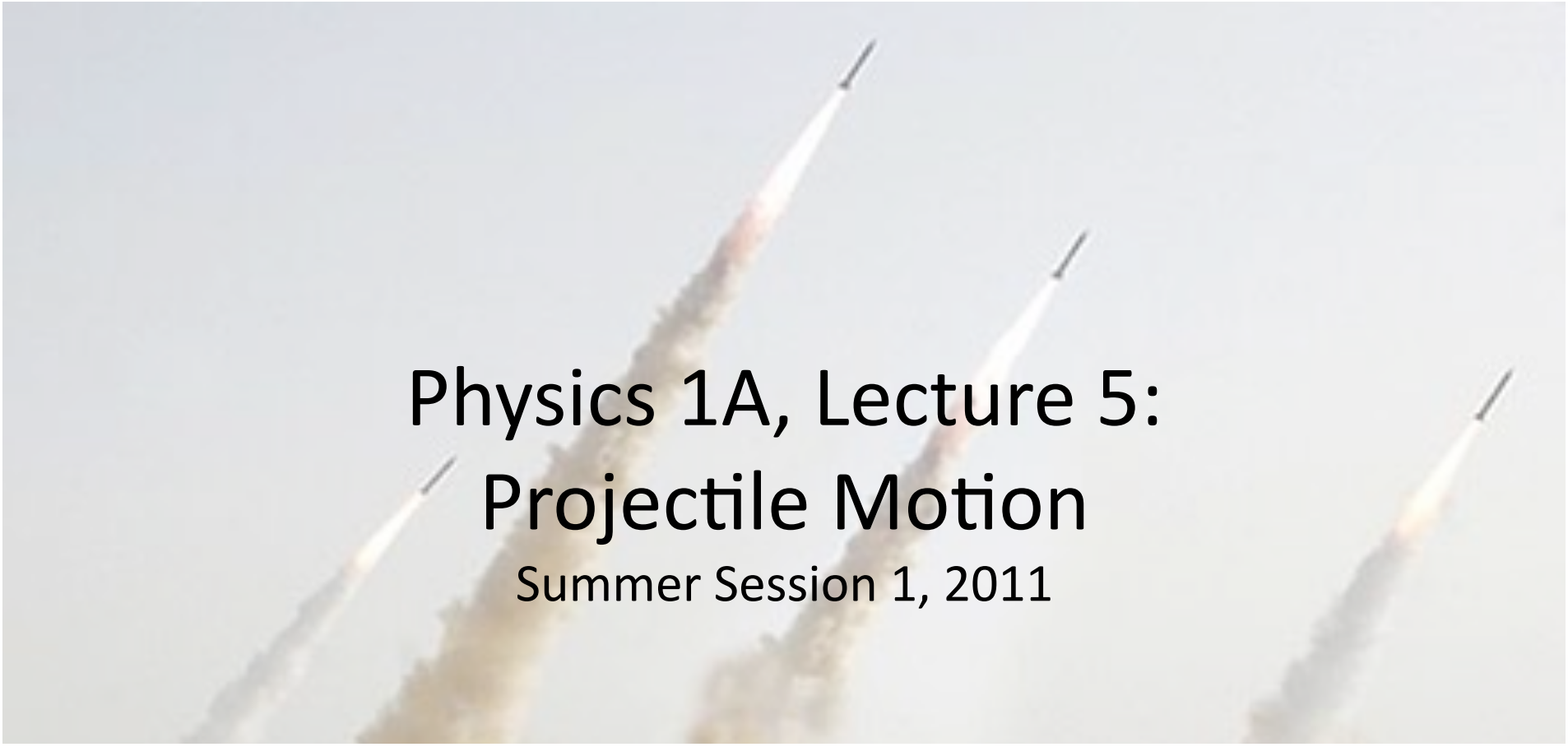


Physics 1A, Lecture 5: Projectile Motion

Summer Session 1, 2011

Your textbook should be closed, though you may use any handwritten notes that you have taken. You will use your clicker to answer these questions. If you do not yet have a clicker, please turn in your answers on a sheet of paper. The quiz will commence at 9:33 AM.

Key Questions: (Discuss with neighbors before quiz)

1) During projectile motion, when are the velocity and acceleration vectors parallel? perpendicular?

2) What variables are held constant during projectile motion?

3) What is the direction of centripedal acceleration in uniform circular motion?

Reading Quiz #3-1

- A cannonball is launched from ground level at an angle 30^o from the horizontal and hits the ground 100 m away. When are the velocity and acceleration vectors of the cannonball parallel?

A) Just when the cannonball is fired

B) When the cannonball achieves its maximum height

C) Just before the cannonball impacts with the ground

D) Never

E) Always

Reading Quiz #3-2

- A cannonball is launched from ground level at an angle 30^o from the horizontal and hits the ground 100 m away. When are the velocity and acceleration vectors of the cannonball perpendicular?

A) Just when the cannonball is fired

B) When the cannonball achieves its maximum height

C) Just before the cannonball impacts with the ground

D) Never

E) Always

Reading Quiz #3-3

- What variables are held constant during projectile motion?

A) Δx and v_x

B) a_y and v_x

C) Δy and v_y

D) only a_y

E) it depends on the launch angle

Reading Quiz #3-4

- What is the direction of centripedal acceleration in uniform circular motion?

A) radially towards the center of the circle

B) radially outwards from the center

C) tangentially along the direction of motion

D) tangentially opposing the direction of motion

E) None of the above

Announcements

- Homework 1 will be returned to you after class or at office hours.
- I will have make up office hours today at 5-6pm in Mayer 5623
- Homework 2 due tomorrow in class or office hours by 1pm
- I will start posting grades this weekend
- Corrections to the homework are posted on the website on the Homework page

Announcements

- Final grade percentages have changed:

- Final 40%
- Quizzes 40%
- Homework 15%
  - (out of 5, each is worth 3%)
- Reading Quizzes 5%
  - (drop lowest 4 out of 12, each is worth 0.625%)
- Clickers 5% (Extra Credit)

Quiz 1 will be in class this Thursday

- It will cover everything from lecture, reading assignments, both homework assignments:
  - Math Review
  - Kinematics equations
  - Free fall
  - Projectile motion (Do extra problems for practice)
  - Uniform Circular Motion
- You will need:
  - Scantron
  - Calculator (not your phone!)
  - #2 pencil
- An equation sheet will be provided
- It will start at 9:30am. We will not have class afterwards, so you can take the full 80 minutes
- It will be 15 multiple choice questions

Today's anonymous poll

Besides 1A and 1AL, how many classes are you taking right now?

A) 0

B) 1

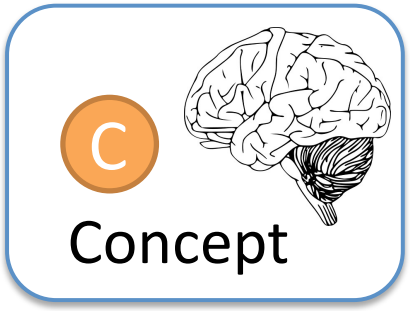
C) 2 or more

D) I haven't decided if I'm taking more classes

E) I haven't decided if I'm taking 1A and 1AL

- Drop without W (Friday, July 8th)
- Drop with W (Tuesday, July 26th)

Force → acceleration



- Huge topic for next section:
  - Only way to have acceleration of an object is when there is a force acting on it
- Three things that cause acceleration:
  - Gravity (always constant in magnitude and direction!)
  - Gas or brake pedal (though cars can also coast)
  - Object in contact with that object applying a force
- Things that *do not* cause acceleration:
  - Throwing stuff (can only cause velocity)

New actors, same roles

$$h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$v_y = v_{0y} + a_y t$$

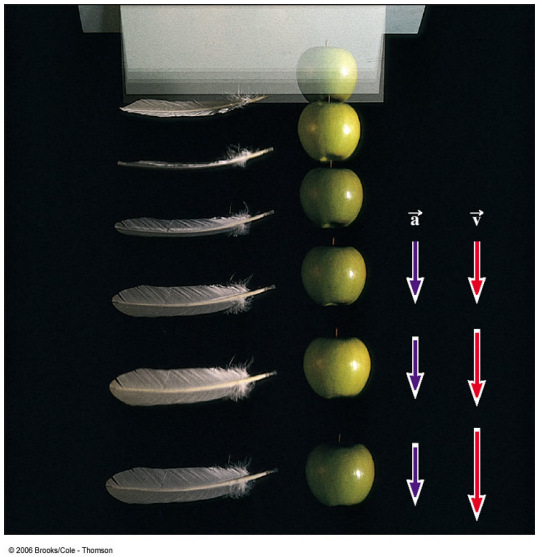
$$h = h_0 + \frac{1}{2}(v_{0y} + v_y)t$$

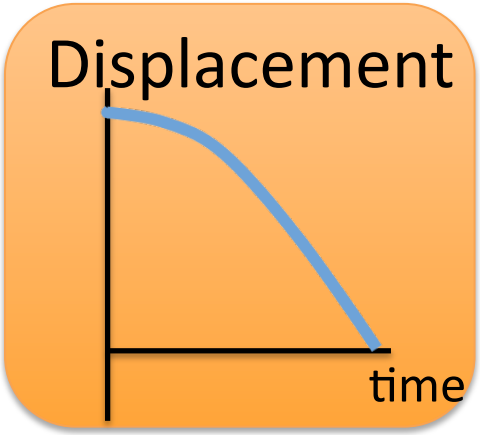
$$v_y^2 = v_0^2 + 2a_y(h - h_0)$$

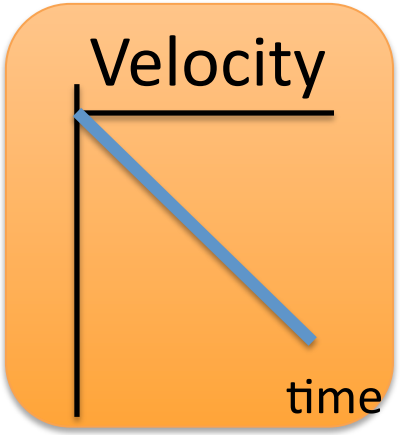
h_0 h

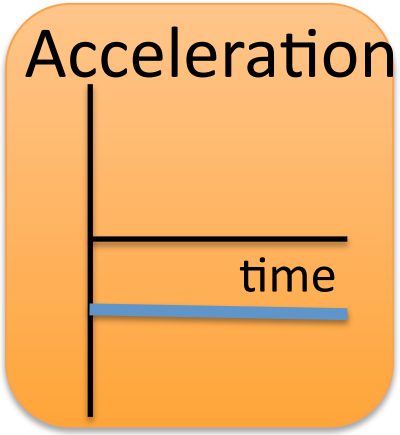
v_{0y} v_y

a_y t









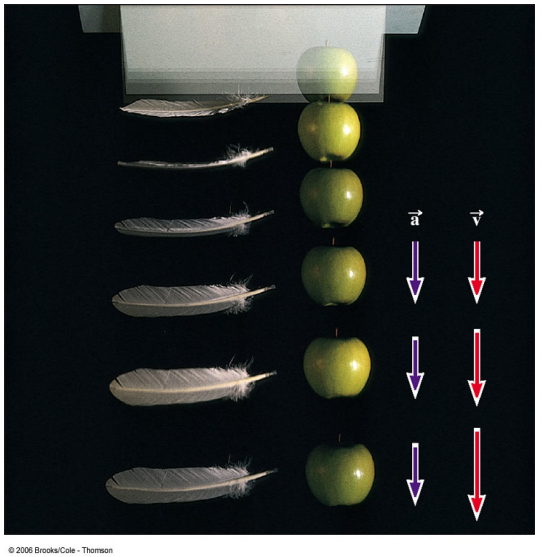
$$a_y = -g$$

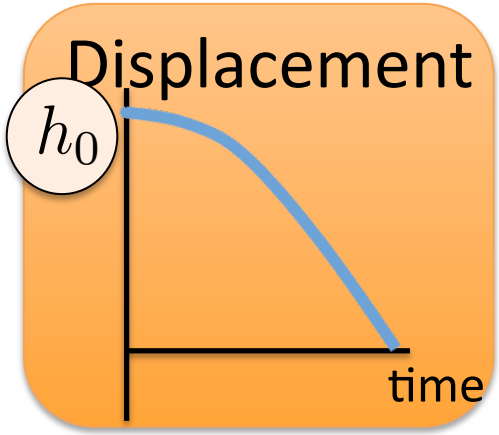
Dropping from rest

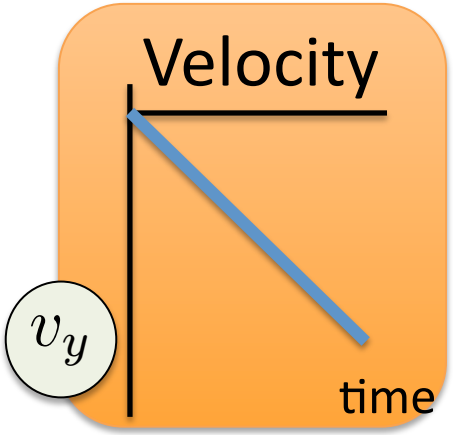
$$h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

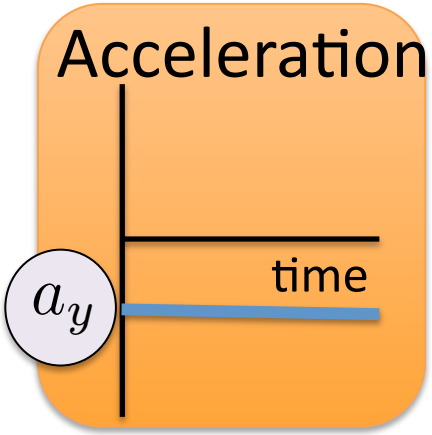
$$h_0 = \frac{1}{2}gt^2$$

h_0 h v_{0y} v_y a_y t





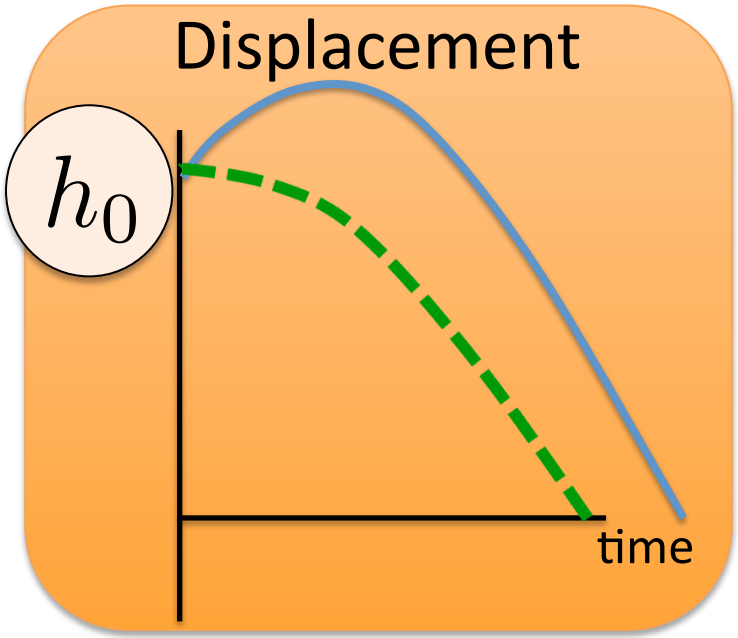




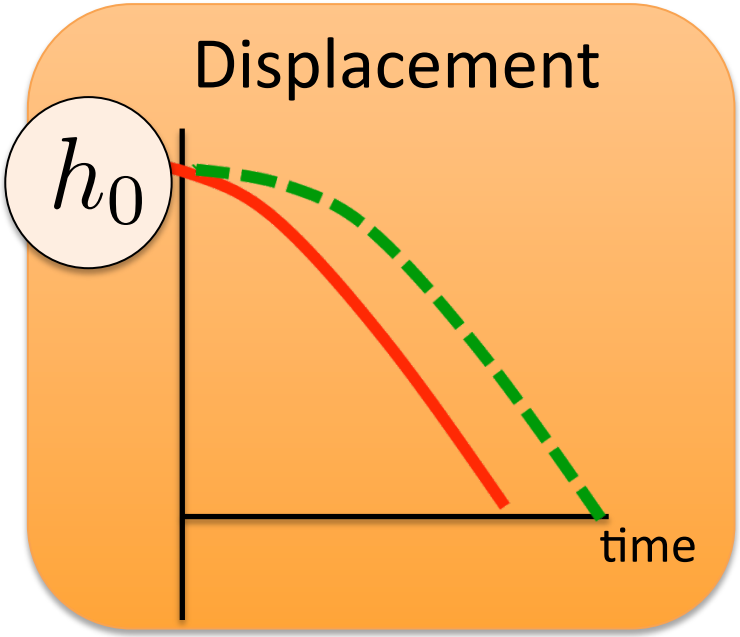
$$a_y = -g$$

Air time depends on v_{0y}

Throwing up



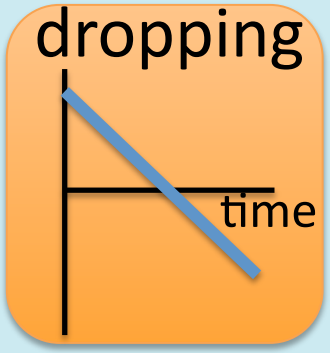
Throwing down



Dropping from rest

Clicker Question 5-1
Free Fall Concepts

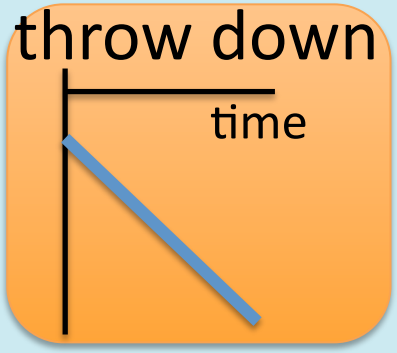
Which of these is the **correct** *velocity* graph in the y direction vs time for the description of motion? The positive y direction points up.

A) 

B) 

C) 

D) 

E) 

Clicker Question 5-2
Free Fall Concepts

Do heavier things fall faster?

A) Yes

B) No

Clicker Question 5-3
Free Fall

Superman needs to leap over a tall building that is 200m tall. What is the minimum initial velocity he needs to clear the building? (Pick the correct collection of Knowns):

A)	$h_0 = 0, h = 200\ \mathrm{m}, a_y = 9.8\ \mathrm{m}/s^2$
B)	$h_0 = 0, h = 200\ \mathrm{m}, a_y = -9.8\ \mathrm{m}/s^2$
C)	$h_0 = 0, h = 200\ \mathrm{m}, v_y = 0, a_y = -9.8\ \mathrm{m}/s^2$
D)	$h_0 = 0, h = 200\ \mathrm{m}, v_y = 0, a_y = 9.8\ \mathrm{m}/s^2$

Clicker Question 5-4
Free Fall

Given the Knowns, which equation should he use to solve for the take off speed?

A) $h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$

B) $v_y = v_{0y} + a_y t$

C) $h = h_0 + \frac{1}{2}(v_{0y} + v_y)t$

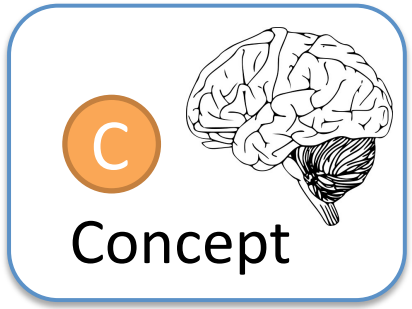
D) $v_y^2 = v_0^2 + 2a_y(h - h_0)$

Knowns:

$$h_0 = 0,$$
$$h = 200 \text{ m},$$
$$v_y = 0,$$
$$a_y = -9.8 \text{ m/s}^2$$

Projectile motion

Projectile motion: Independence of motion in x and y



Kinematics in x:

$$x_f = x_0 + v_{0x}t + [redacted]$$

$$v_x = v_{0x} + [redacted]$$

$$x_f = x_0 + \frac{1}{2}(v_x + v_{0x})t$$

$$v_x^2 = v_{0x}^2 + [redacted]$$

x_0 x_f v_{0x} v_x ~~a_x~~ t

Velocity in x direction is constant!

Kinematics in y:

$$h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$v_y = v_{0y} + a_y t$$

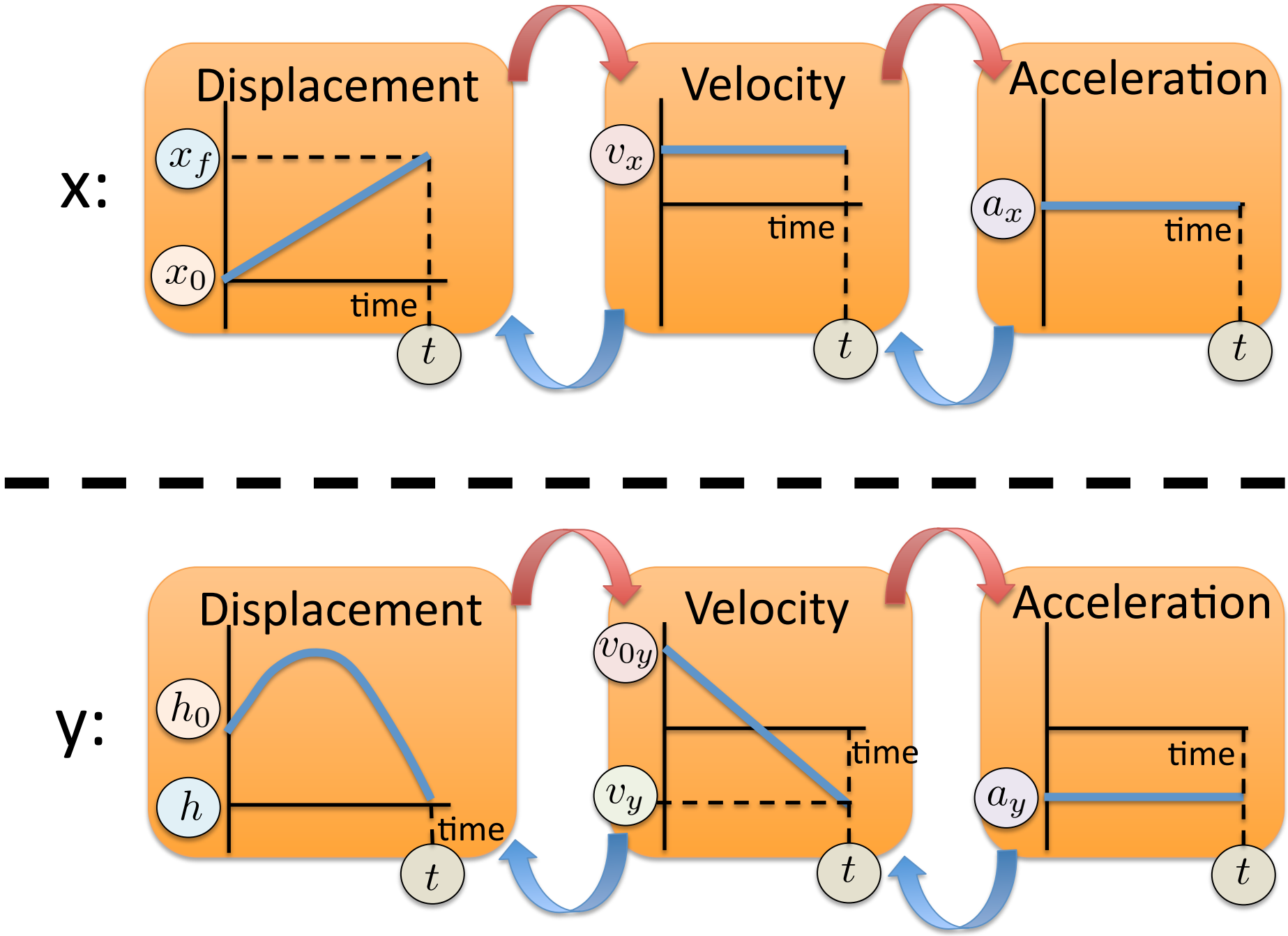
$$h = h_0 + \frac{1}{2}(v_{0y} + v_y)t$$

$$v_y^2 = v_0^2 + 2a_y(h - h_0)$$

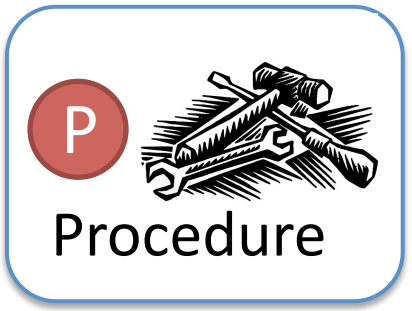
h_0 h v_{0y} v_y a_y t

$$a_y = -g$$

Acceleration in y direction is constant!


x:
Displacement
x_f
x_0
time
t
Velocity
v_x
time
t
Acceleration
a_x
time
t
y:
Displacement
h_0
h
time
t
Velocity
v_{0y}
v_y
time
t
Acceleration
a_y
time
t

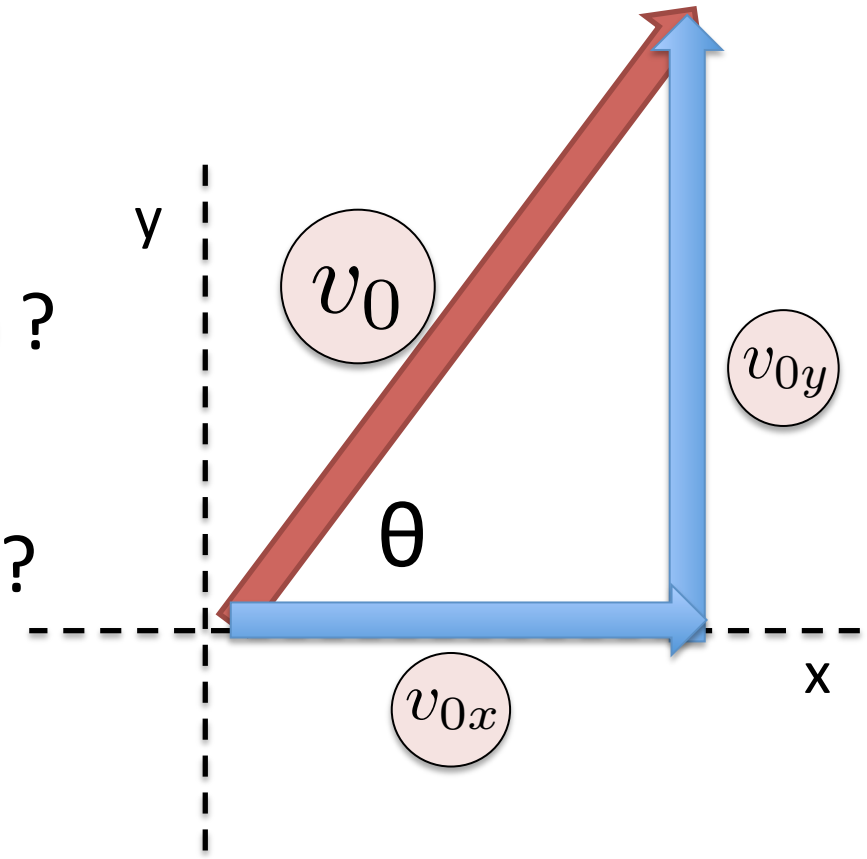
Projectile Motion: Find components of velocity



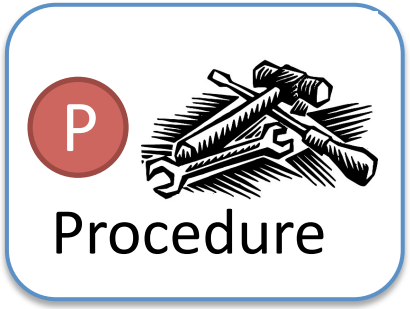
- Usually given initial velocity and angle from the horizontal:

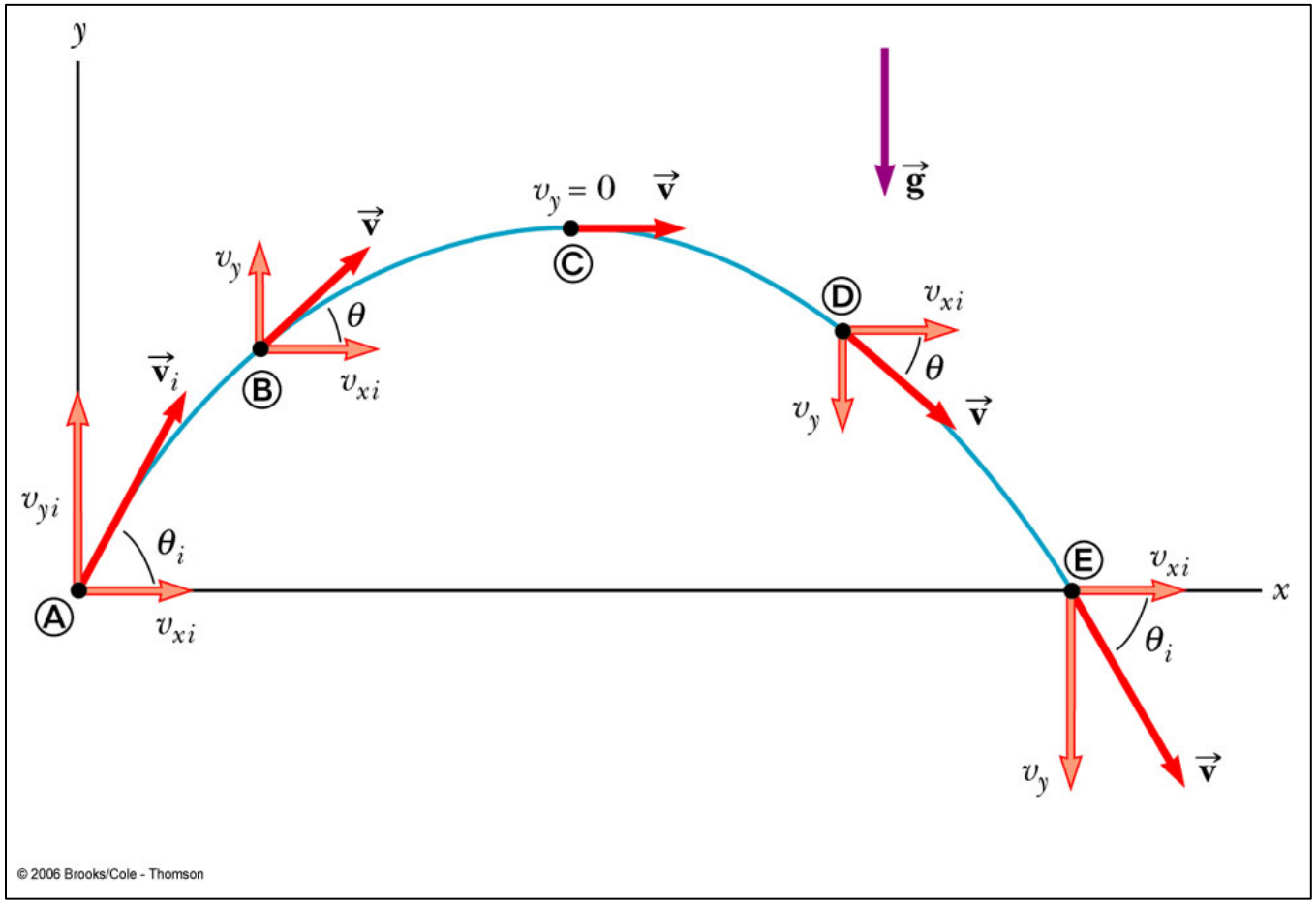
$$v_{0x} = v_0 \cos\theta$$
$$v_{0y} = v_0 \sin\theta$$

- What happens to v_{0x} ?
- What happens to v_{0y} ?

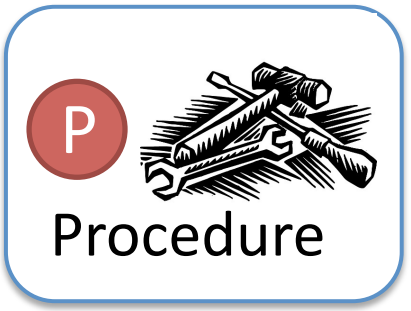


Projectile velocity and acceleration



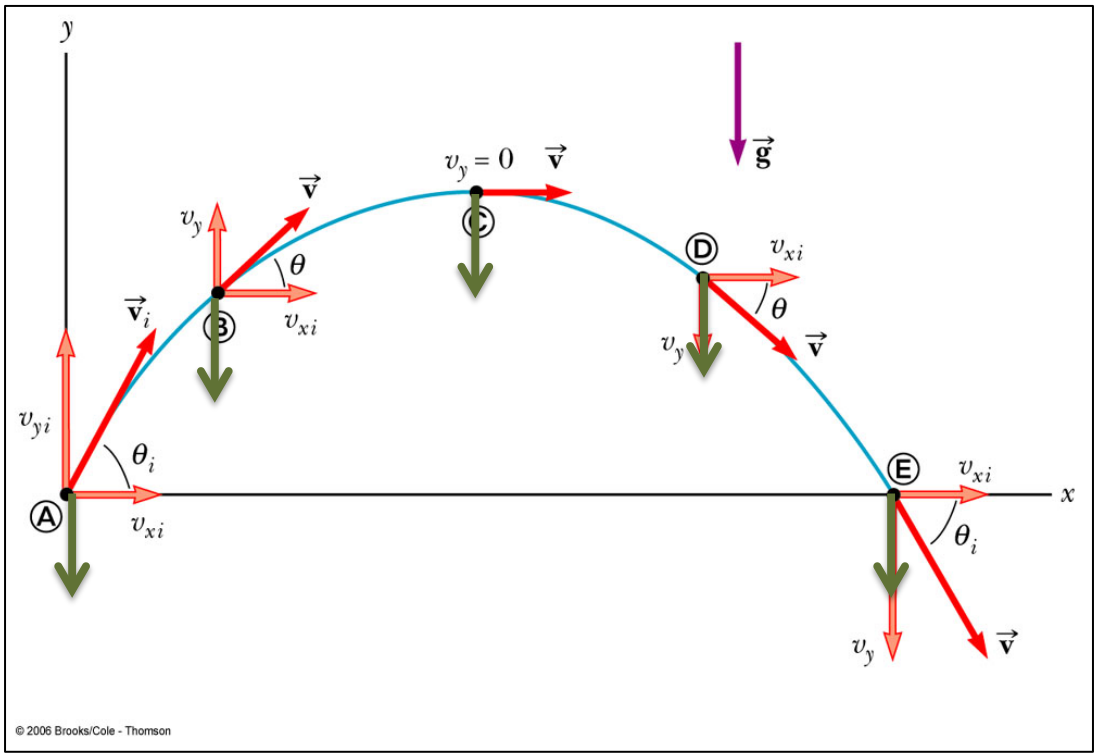


Projectile velocity and acceleration



- Constant v_x
- v_y decreases to zero then decreases to negative v_{0y}
- Constant a_y

$$a_y = -g$$



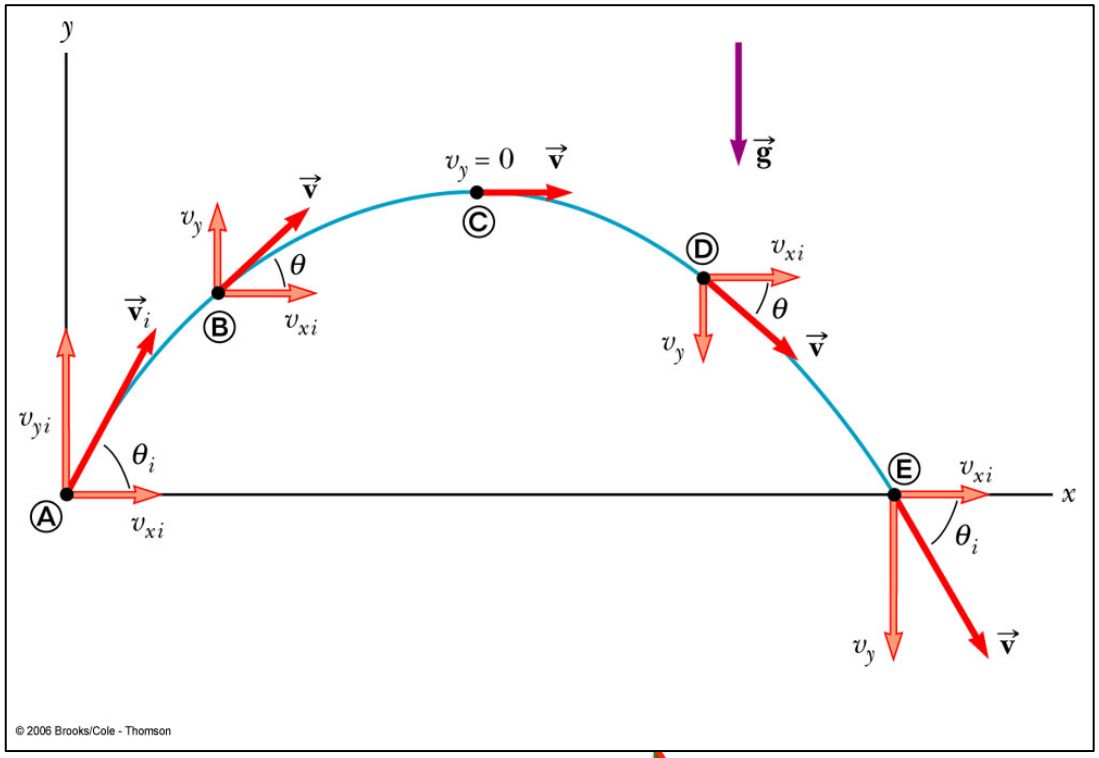
Projectile velocity and acceleration

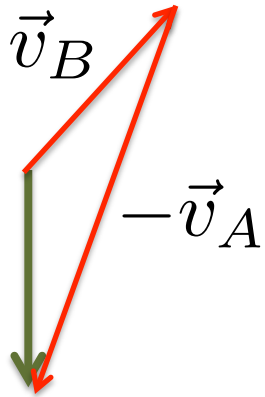
C

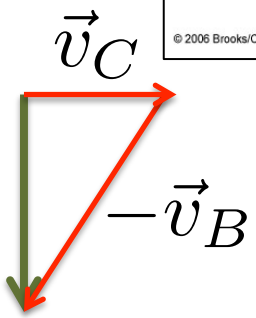
Concept

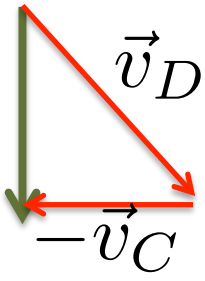
$$\Delta\vec{v} = \vec{v}_2 - \vec{v}_1$$

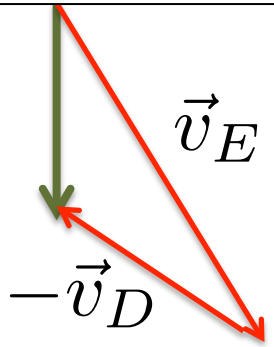
$$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$$



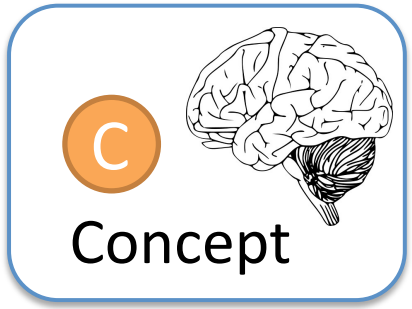








Projectile motion: Independence of motion in x and y



Kinematics in x:

$$x_f = x_0 + v_{0x}t + [redacted]$$

$$v_x = v_{0x} + [redacted]$$

$$x_f = x_0 + \frac{1}{2}(v_x + v_{0x})t$$

$$v_x^2 = v_{0x}^2 + [redacted]$$

x_0 x_f v_{0x} v_x ~~a_x~~ t

Velocity in x direction is constant!

Kinematics in y:

$$h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$v_y = v_{0y} + a_y t$$

$$h = h_0 + \frac{1}{2}(v_{0y} + v_y)t$$

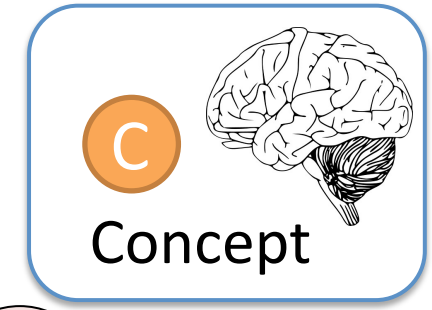
$$v_y^2 = v_0^2 + 2a_y(h - h_0)$$

h_0 h v_{0y} v_y a_y t

$$a_y = -g$$

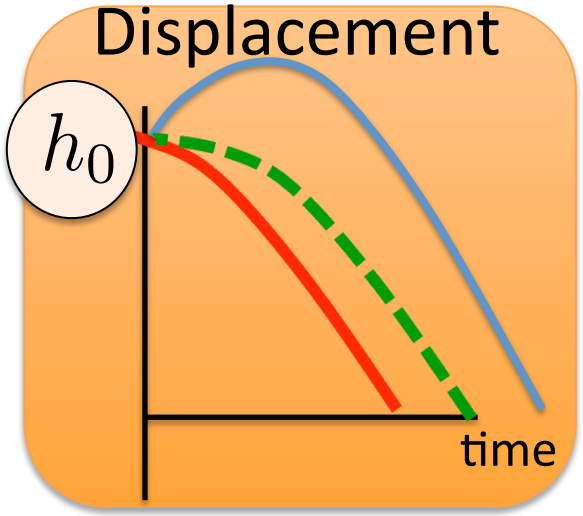
Acceleration in y direction is constant!

What determines air time and range?



- Air time is determined by h_0 and v_{0y}

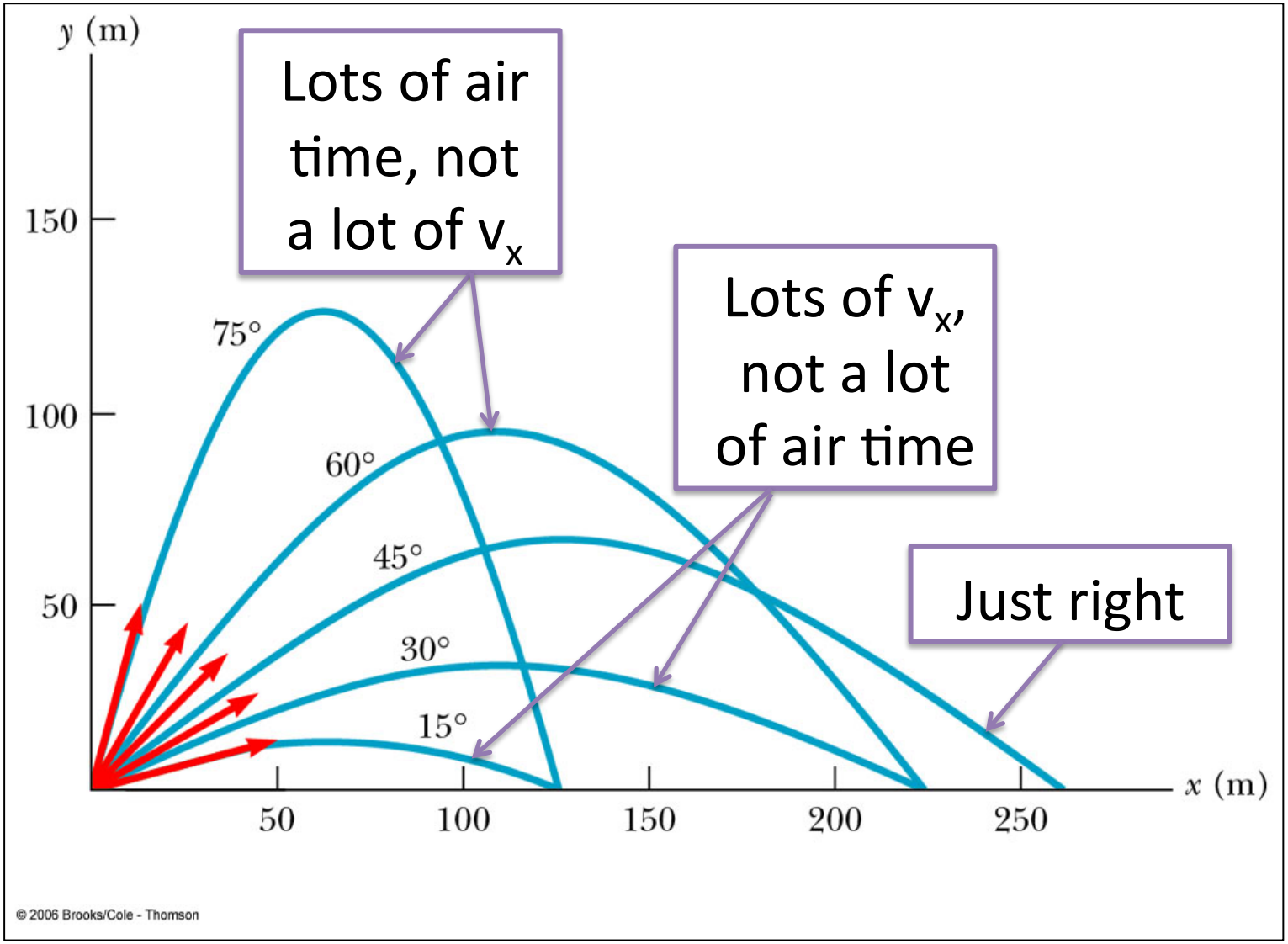
$$h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$$



- Range is determined air time and v_{0x}

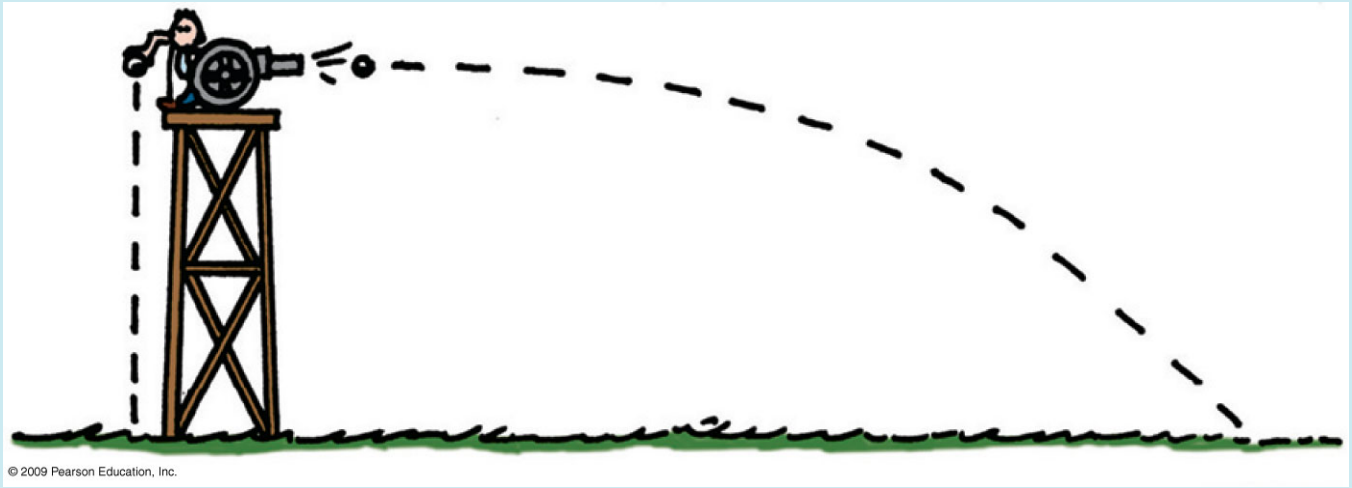
$$\Delta x = v_{0x}t$$

Maximize range with launch angle



Clicker Question 5-5

A man drops a cannonball from rest just as the cannon launches horizontally. Which ball will hit the ground first?



A) the one that is dropped

B) the one that is fired

C) both will hit at the same time

Clicker Question 5-6

- A hunter tries to shoot a rare monkey hanging from a tree with a dart gun. The hunter has the monkey in his sights. But the monkey notices the hunter and drops from the branch exactly when he hears the hunter fire. Will the hunter hit or miss the monkey?

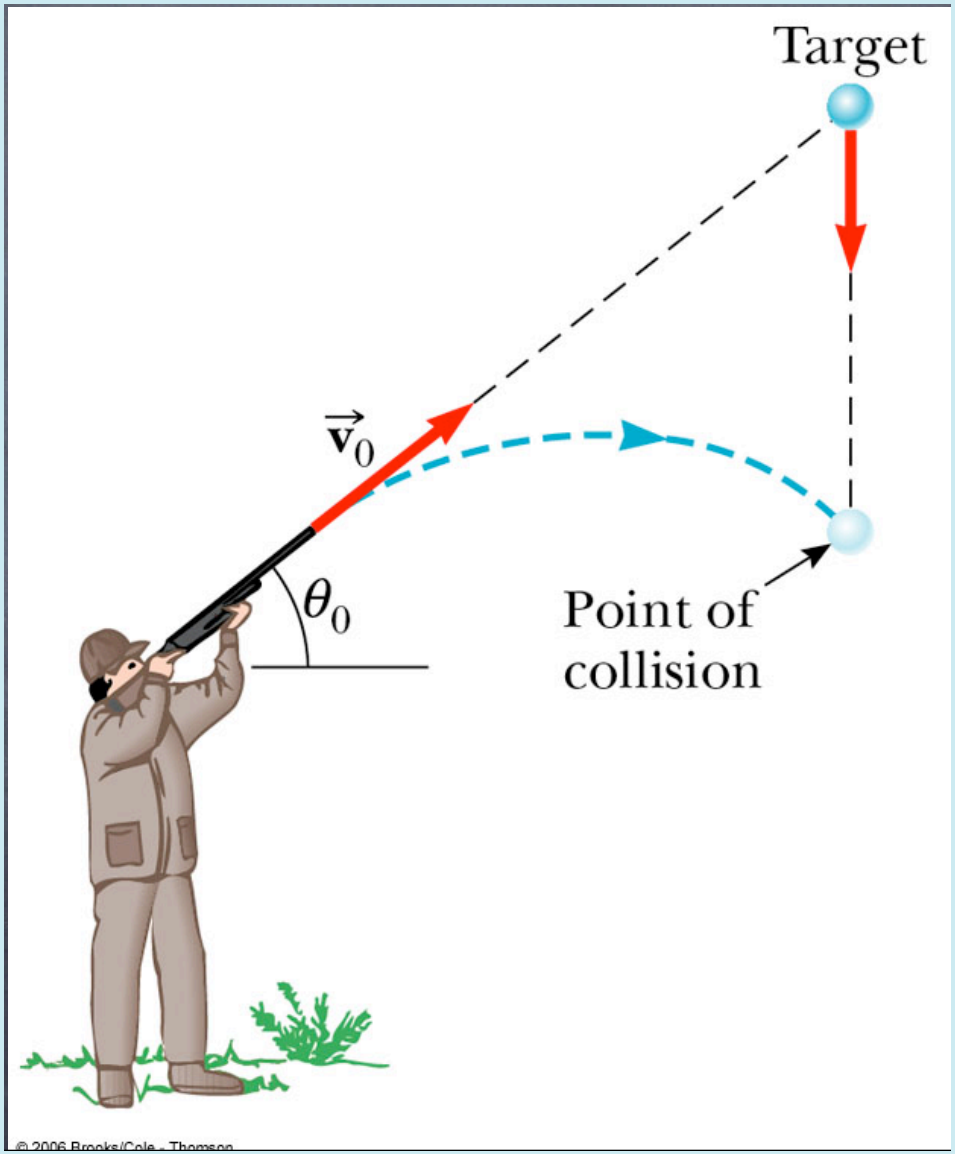
A) The dart will hit the monkey.

B) The dart will miss above the monkey.

C) The dart will miss below the monkey.

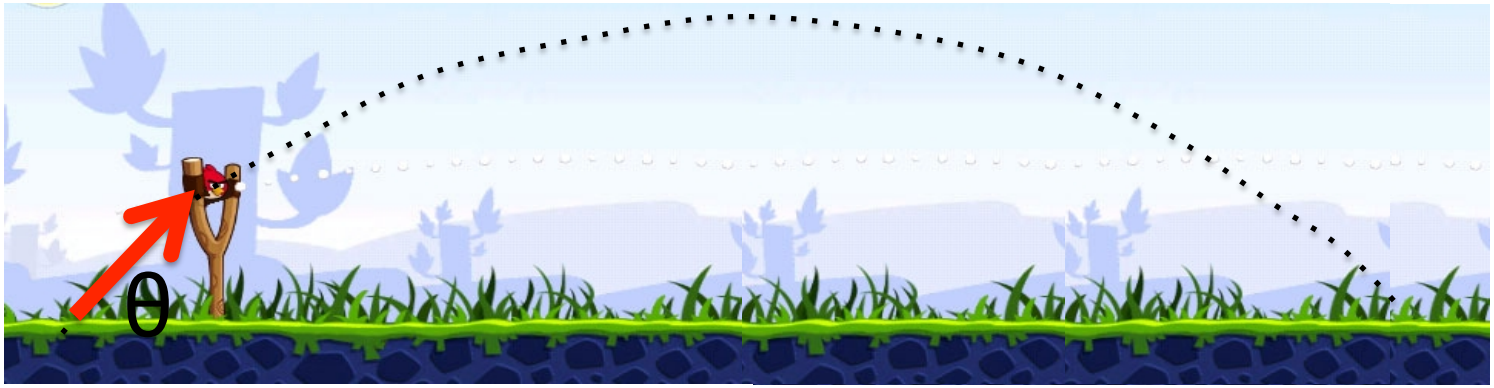
Clicker Question 5-6

- The bullet and the monkey both fall under the influence of gravity.

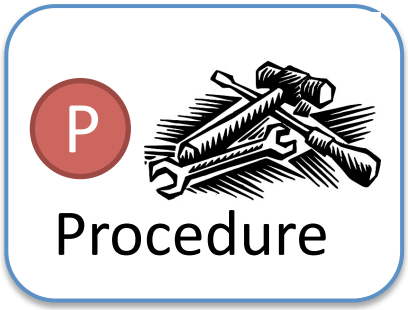


Solving the classic projectile problem:

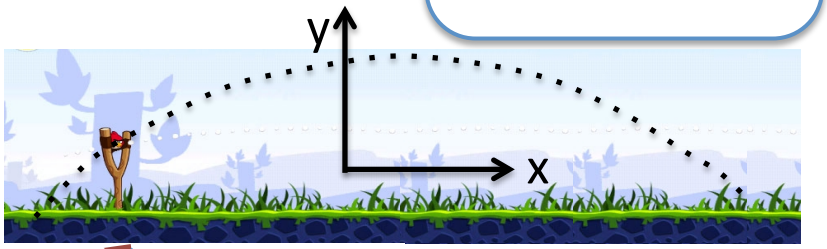
- An angry bird is launched from ground level at an angle 60.0^{o} with a velocity of 100.0 m/s. How far away does it land when it falls back to the ground?

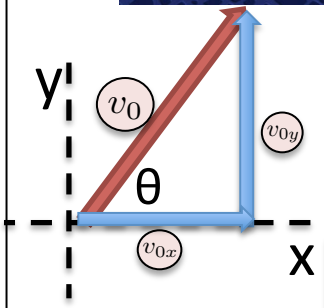


How to solve projectile problems



1) Draw a picture with a coordinate system
2) Collect all the knowns and unknowns, break up velocity into *x* and *y* components
3) Find the appropriate equations
4) Use *t* to connect between equations in *x* and *y*. Solve.





h_0 h v_{0y} a_y

x_0 v_x

x_f

$$v_{0x} = v_0 \cos\theta$$
$$v_{0y} = v_0 \sin\theta$$

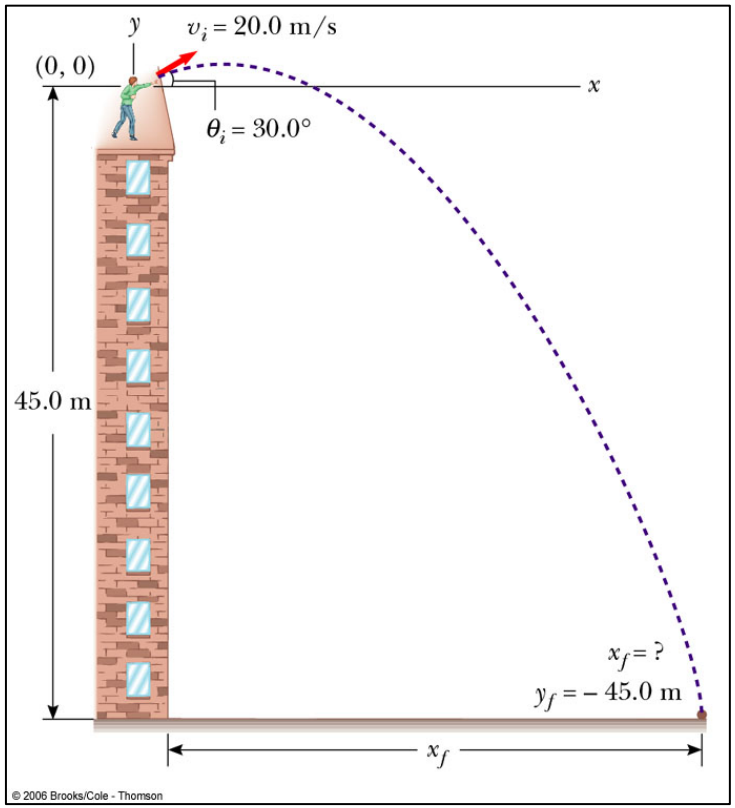
$$h = h_0 + v_{0y}t + \frac{1}{2}a_y t^2$$

$$\Delta x = v_{0x}t$$

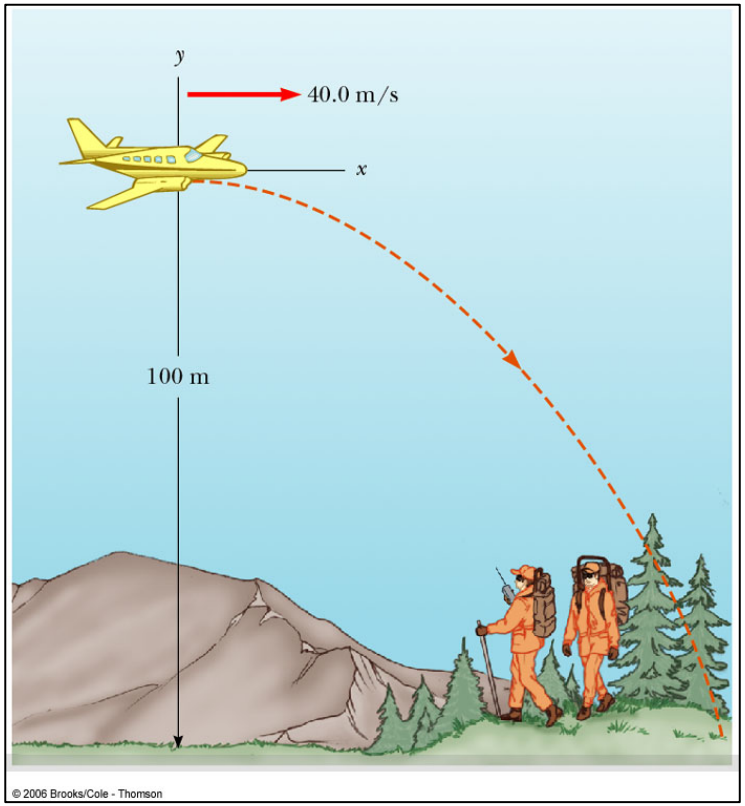
$$t = \frac{2v_{0y}}{g} \rightarrow \Delta x = \frac{2v_{0y}v_{0x}}{g}$$
$$= 866 \text{ m}$$

Slight variations on the classic projectile problem:

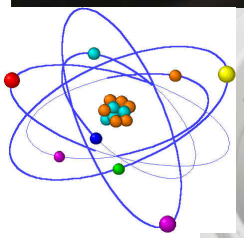
- Initial height is not zero

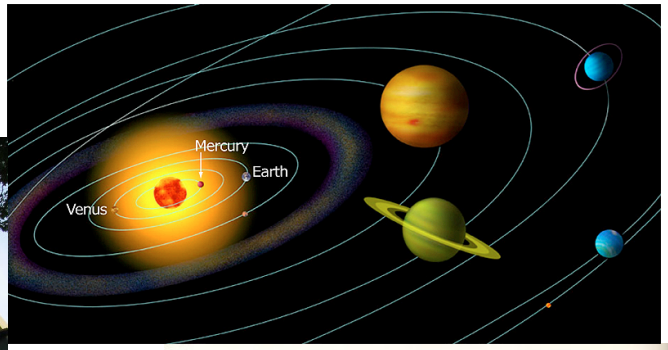


- Drop from a plane
  - v_x is velocity of the plane

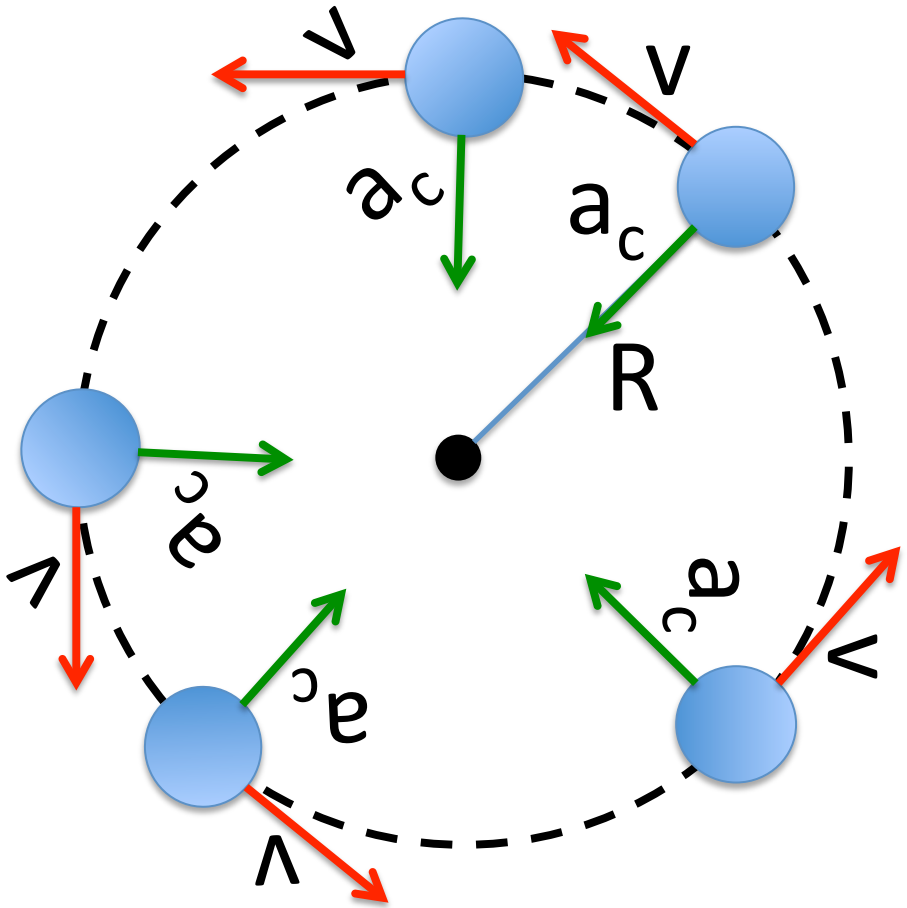


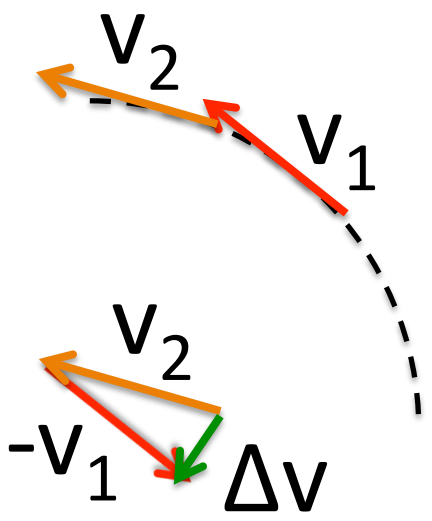
Uniform circular motion





Uniform circular motion





$$a_c = \frac{v^2}{r}$$

$$T = \frac{2\pi r}{v}$$

Homework

- Quiz #1 will be Thursday, covering Ch 1-3
  - This covers the Math review and Kinematics
- Homework #2 is due tomorrow
  - Download this from the website
  - Solutions will be posted at 1pm, so no late homework will be accepted
- Get ready for tomorrow's reading quiz
  - See assignment and questions posted on website